Alberta Innovates
Energy and Environment Solutions

Powerful ideas Global impact

STRATEGIC BUSINESS PLAN

April 2011

Table of Contents

Executive Summary 3

Board of Directors 6

The Context 7

Competitive Scan 10

Consultation and Alignment 12

AI-EES Program 14

Capacity Requirements 23

Budget 27

Executive Summary

Alberta Innovates – Energy and Environment Solutions (AI-EES) is part of Alberta Innovates, a new collaborative system built on a strong legacy and proven success. Within this Strategic Business Plan, you will read about our purpose, priorities and goals as well as the new research, and technology developments and projects that could change the way people think about responsible energy development, the Alberta oil sands, clean energy and more effective management of greenhouse gases and water. You will also gain an understanding of how we are working to implement the goals of the province's strategies in energy, oil sands, climate change and water.

AI-EES will take bold, decisive action to implement energy and environmental innovations. AI-EES' actions in advancing technology will enable Alberta to achieve competitive advantage, greater sustainability and manage external risks.

EXPECTED OUTCOMES

AI-EES has completed a thorough examination of the environment in which we work, analyzed numerous studies and roadmaps, and consulted with many stakeholders. In so doing, AI-EES has established three strategic program areas:

- ***Energy Technologies*** including programs in Recovery and Processing, Clean Carbon, and Unconventional Gas;
- ***Environmental Management*** including programs in Water (AWRI), Oil Sands Tailings, Enhanced Ecology and Carbon Capture and Storage; and
- ***Renewable and Emerging Resources*** including programs in Renewable Energy and Alternate Fuels.

To reach our goals, AI-EES has established long term targets aligned with provincial strategies. Upon reaching these targets, AI-EES will have achieved the early stages of its mandate and mission. These targets are summarized as follows:

TECHNOLOGIES AND MANAGEMENT TARGETS BY 2020		
De-Carbonization	Clean Energy	Clean Water
• 50% reduction on GHG emissions on a per equivalent barrel basis	• 20% of energy is derived from renewable resouces	• 30% increase in water efficiency
• 20% reduction in energy consumed in the production of bitumen	• Coal-fired power plants in Alberta at natural gas equivalent	• 75 million m^3 reduction from Directive 074 target
COMMERCIAL AND NEXT-GENERATION		
• 3.0 million barrels per day of heavy oil and bitumen production • 20% increase in conventional oil recovery • 15% of gas will come from non-conventional sources		

Figure 1: Goals and targets used to assess the benefits of AI-EES initiatives.

AI-EES believes that these targets can be achieved by following a systematic process and by making strategic investments in research, technology and innovation. In reaching for these targets, AI-EES' programs will position Alberta to triumph in the shifting picture of the international marketplace, reduce environmental and social impacts from all sources of supply, and lead to new technology skills. AI-EES will contribute to building a culture of business innovation that responds to the challenges and the opportunities presented by a changing world and by consumer expectations.

BUILDING ON SUCCESS

AI-EES is the successor to the Alberta Energy Research Institute (AERI) and the Alberta Oil Sands Technology and Research Authority (AOSTRA). With the incorporation of the Alberta Water Research Institute (AWRI), we are well-positioned to tackle today's environment and technology challenges. As the lead agency for energy and environmental research and innovation in Alberta, AI-EES acts as a catalyst for developing innovative, integrated ways to convert our natural resources into market-ready, environmentally responsible energy, and provide a technology context to government policy makers.

ORGANIZATION	STRATEGIC DRIVERS	POSITIONING	OUTCOME
AOSTRA (1974-1999)	Declining Conventional Oil Production	Technology to make oil sands competitive in world markets	"technology oil"
AERI (2000-2009)	Clean Energy Development	...include all forms of energy importance to Alberta	"integrated energy economy"
EES (2010-)	Technology Implementation: • Responsible Actions: A Plan for the Oil Sands • Provincial Energy Strategy • Climate Change Strategy • Renewed Water for life	...expand to include sustainable development as a powerful instrument of government policy	"international leader in the low carbon clean energy & clean water economy"

Figure 2: Building on success.

WATER RESOURCES – A NEW STRATEGIC AREA OF FOCUS

In 2011-12, AI-EES will complete the integration of the Alberta Water Research Institute program, by developing a new strategic area called Water Resources (AWRI). To create this new strategic area, AI-EES will use established processes to create a broad-based water resources vision and supporting goals. We will start by looking at past successes of AWRI and the flagship projects already underway and identify the principles and policies that led to success. We will appoint new Board Members to the AI-EES board that have a specific knowledge and understanding of water issues and will hold a visioning session with our partners in the Alberta Innovates corporations, Alberta government, industry and non-government organizations. AI-EES will then create a sub-committee of the Board that will work to develop water priorities and identify and provide the appropriate scope for specific research projects. Through this integration, AI-EES will become known for its efforts to secure water supplies for Alberta's future.

WORKING STRATEGICALLY WITH INDUSTRY, GOVERNMENT AND INSTITUTIONS

A fundamental component of the new research and innovation system is to better address government priorities by building stronger synergy and connections among the Alberta Innovates corporations, government ministries, industry groups, post-secondary institutions and other stakeholders. Therefore, we developed our strategic business plan in consultation with relevant ministries, corporations and key research funders and performers.

As the lead agency for energy and environmental research in Alberta, AI-EES brings together decision makers from government and industry as well as research and technology organizations, to develop solutions for the biggest challenges facing Alberta's energy and environment sector. Our commitment to open innovation means knowledge on clean energy technology is shared to speed up technology development worldwide.

BARRIERS TO MEETING LONG TERM GOALS

While AI-EES has developed plans, identified targets, and works hard to leverage partnerships, its resources are limited and there are barriers to the realization of the goals outlined in this plan.

With our broader mandate a number of new capacity gaps were identified — sustainable monitoring, water and tailings management, biodiversity solutions, biological systems and sustainable engineering. Developing research capacity in these areas will require re-balancing the portfolio based on available funding. This means that not all existing programs will continue to be funded.

Capacity for demonstrating new technology and the training of technical specialists who can advance technology innovations is limited.

IMPACT ON ALBERTANS

Working with key government and industry stakeholders and research providers, AI-EES enables Alberta to be at the forefront of technologies such as gasification, upgrading, carbon capture and storage, and advanced recovery, while also making important contributions in the areas of water, tailings management, life cycle analysis and underground coal gasification. This unique expertise is vital to Alberta's commitment to the "science of solutions" in energy and the environment. As a result, our researchers, entrepreneurs and businesses are setting global standards for reducing environmental impacts and supporting greener communities.

This plan has the potential to prepare Alberta for the future in energy and environment by providing sensible solutions. The remainder of this plan will outline how AI-EES intends to work for Albertans to:

- Drive Alberta to become an international leader in generating low carbon, clean energy and a clean water economy;
- Provide leadership and act as a catalyst for advancing technology to be used in innovative, integrated ways to convert our natural resources into market-ready, environmentally responsible energy; and
- Increase Alberta's competitiveness and build the knowledge capacity to ensure employment of skilled professionals.

At AI-EES we are working to enhance the economic, environmental and social well-being of all Albertans, Canadians and those beyond our borders.

Board of Directors

The Board of Directors for Alberta Innovates – Energy and Environment Solutions was officially appointed by the Government of Alberta on January 4, 2010.

Eric Newell, *Chair*

Kathleen Sendall, *Vice-Chair*

Directors:

Doug Beever

Paul Clark

David Lewin

David Lynch

Aaron Falkenberg

Charlie Fischer

Paul Galachiuk

Robert Mansell

Genia Leskiw, MLA Bonnyville Cold Lake and Government of Alberta Liaison for Energy and Environment Solutions

Eddy Isaacs, CEO of Energy and Environment Solutions, ex-officio member of The Board

The Context

Alberta has enormous potential to supply clean energy to world markets yet our resources are challenging to extract and threatened due to environmental limitations. Alberta's conventional oil and gas supplies are declining, and relying solely on current methods of production isn't an option. We also want to do more to protect the environment, by reducing greenhouse gas emissions and preserving our valued water resources.

There are great uncertainties about water throughout the province as a result of climate change and industrial impacts. These factors, combined with the need to protect the environment, develop sustainable water management outcomes, and reduce greenhouse gas (GHG) emissions, will severely test Alberta's ability to meet domestic energy needs, expand its export markets, and ensure that it obtains maximum value from both its non-renewable and renewable energy resources. Alberta only has so much water and we need to make difficult decisions about how to live with a limited and sustainable supply.

At our very core, AI-EES is focused on advancing technologies and practices that reduce carbon emissions across the energy industry, and the amount of water used across the province.

MANDATE

AI-EES is the technology implementation arm of Alberta ministries and departments in energy and environment research, development and demonstration, applying world-class innovation management strategies and building leading-edge research capacity to preserve and enhance Alberta's economic, environmental and social well being.

AI-EES applies technical and engineering rigor to the assessment and selection of strategic energy and environmental technologies and selects partners to create significant potential for economic benefits to Alberta. AI-EES-led collaborations are pursuing the next generation of solutions in energy (such as electrical heating recovery process, developing hydrogen systems and clean coal), environment (such as carbon capture, tailings and assessing aquatic ecosystems) and renewables (waste-to-biofuels and geothermal energy). By consolidating, integrating and focusing work across all sectors, AI-EES will achieve its mandate as the technology arm of the Alberta Government. Through our work, AI-EES will:

LEAD: by developing and implementing strategies to position Alberta for the future in energy, and environmental, renewable and emerging technologies.

SERVE: Advanced Education and Technology (AET), Alberta Energy (ADOE), Alberta Environment (AENV), Finance & Enterprise (F&E) and Sustainable Resource Development (SRD), by identifying and selecting technologies and partners.

INVEST: in strategic technology development with industry partners and international collaborators.

Our collaborators include companies such as Nexen, Enerkem, Sherritt, Veolia, General Electric, Pratt and Whitney Rocketdyne, UOP LLC and Suncor Energy. We also work with research organizations such as the University of Alberta, University of Calgary and Alberta Innovates – Technology Futures, as well as federal agencies such as; Natural Resources Canada, and international organizations, including; the International Energy Agency, the U.S. Department of Energy, the Electric Power Research Institute of the U.S. and the Helmholtz Association of Germany.

VISION[1]

Alberta leads the world in developing innovative energy and environmental technologies building on our natural advantages to achieve a prosperous, environmentally and socially sustainable diversified economy

MISSION

To increase Alberta's capacity to develop and successfully adapt innovative technologies that maximize the value of Alberta's natural and renewable resources while protecting the environment.

AI-EES achieves its mission by:

- Promoting collaborative research and development along the entire innovation chain, in partnership with industry and other funding organizations;
- Working closely with the Alberta Innovates corporations and the Alberta departments of Energy, Environment, Finance and Enterprise, and Sustainable Resource Development to strengthen the province's energy and environmental sectors; and
- Taking a strategic view that links knowledge and needs; and acquires advances and integrates the knowledge vital to maintaining Alberta's global leadership in energy and the environment.

OUR STRATEGIC PRIORITIES AND APPROACH

AI-EES takes a strategic approach in collaborations with industry and with others in the Alberta Innovates and Campus Alberta systems to ensure that our investments in research and technology align with the priorities of our sole shareholder, the Government of Alberta (GOA). With a budget of more than $67 million over the next three years, the goals and outcomes outlined in this business plan are targeted to the adaption of new knowledge, and the application of that knowledge to advance commercial solutions within the energy and environment sector.

The Board of Directors for AI-EES has approved the business plan for 2011-14, including a focus on three strategic areas: energy technologies, environmental management, and renewable and emerging resources. Our specific goals under those priority areas are to:

- **Deliver the lowest carbon emissions clean fuels and electricity;**
- **Have the best available environmental technologies and management systems to sustain the environment and economy; and**
- **Make Alberta into a renewable and emerging energy powerhouse.**

1 Vision Statement approved by AI-EES Board, Feb. 11, 2010

LINKING KNOWLEDGE WITH SOLUTIONS NEEDS

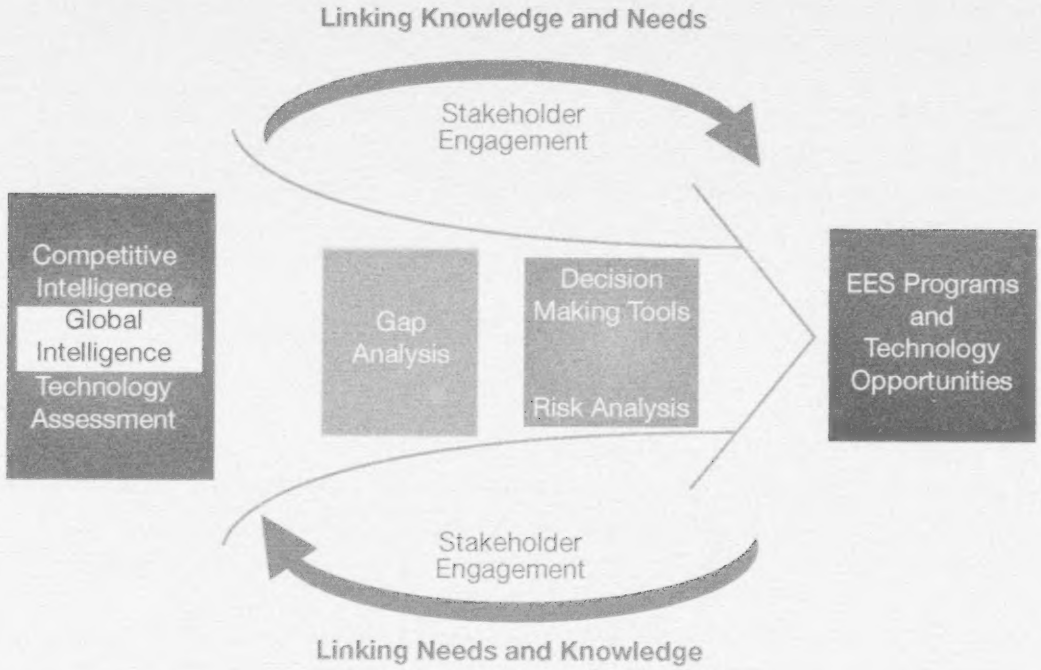

Figure 3: Schematic illustrating the process by which AI-EES defines its priorities and takes coherent actions to achieve the strategic program objectives.

AI-EES' process for defining its programs and priorities is illustrated above. This process has been successful in deploying global knowledge and capabilities to meet the needs of Alberta's energy sector. It is now being expanded to meet environmental needs and link the capabilities of the Alberta Innovates corporations. AI-EES staff work with in-house and external specialists to define critical technology gaps and formulate SMART[2] objectives for each gap. Decision making tools are used to select the most suitable technologies and partners to undertake projects capable of filling the gaps. By focusing resources on technology platforms that offer solutions to a number of gaps and by working in partnership with industry and other research and development organizations, AI-EES gets maximum leverage of government investments to achieve the desired results, impacts and benefits for Alberta.

2 *SMART: Specific, Measurable, Actionable, Realistic, Timely*

Competitive Scan

The following is a high-level environmental scan for AI-EES.

TRENDS AND IMPLICATIONS

TRENDS	IMPLICATIONS FOR ALBERTA
The global economy is increasingly characterized by greater energy demand, huge uncertainties, changing market dynamics and demand for environmentally friendly goods and services.	A business-as-usual approach carries huge risks for Alberta. A transformative strategy is needed to diversify both markets and products for exports and achieve a paradigm shift in environmental performance.
The United States emphasis on energy security, combined with reducing oil imports, impact of Energy Security Acts, assigning responsibility for GHG emissions to individual sectors.	Alberta's energy sector must invest in clean energy extraction technologies, carbon capture and storage, and renewable energy technologies, in order to remain The United States' preferred energy supplier.
Introduction of Low Carbon Fuel Standards in California, 14 other U.S. States, Ontario and British Columbia.	This is a major threat to our energy sector, but it can be alleviated by acting on the strategies listed in the Climate Change Strategy: greening energy production, implementing carbon capture and storage, and improving energy efficiency and conservation.
Market Trends – growing demand for clean fuels (increased production of cleaner fossil fuels, biofuels and electrification of the transportation system) in North America.	Results in decreased demands for gasoline and diesel and potential lower oil and gas prices and sales. This could have serious implications for the province's economy, particularly lower employment in the energy industry and reduced royalties payable to the Provincial treasury.
Abundant natural gas supplies – some of which are due to major shale gas discoveries – near U.S. and Eastern Canadian markets and improved production technologies will keep gas prices depressed.	Alberta's natural gas supply cost is disadvantaged in comparison to conventional gas (unconventional gas is costly to produce and distant from markets). While tight gas accounts for about a third of Alberta's natural gas production, without technological breakthroughs it is likely that growth in Alberta unconventional gas will be modest at best.
Strong demand in renewable and alternative fuels (e.g. Alberta standard is for 2% biodiesel and 5% ethanol in transportation fuels).	Alberta has the infrastructure and expertise to develop other fuel sources and could lead the transition to a global, low-carbon economy. Standards need to be considered and developed.
Uncertainty about water supply into the future due to water scarcity, melting glaciers, low water tables and overuse may mean less water for all users.	There will be increased pressure on all industries to show improved water management performance. Government will need to develop science-based policy and regulation to reverse unsustainable trends and to provide oversight.
The high cost and long lead times necessary to commercialize new clean energy technologies requires sustained, long-term government support.	Alberta needs to stay the course in terms of long-term, sustained funding for research and innovation in energy and the environment.
Increasing oil production in Alberta due to increased pressure from U.S. and global markets for greater energy supplies and security.	Alberta needs technology breakthroughs in production performance for both conventional heavy oils and oil sands that are considerate of environmental goals to reduce carbon footprint, improve water quality and reclaim industrial land.

ALBERTA DRIVERS

- The rate of energy development is perceived to have outpaced environmental and social acceptance of the energy industry
- Cumulative effects in air, water and land use will limit economic growth
- Alberta's economy depends on energy exports, but they must be clean
- Clean energy products and markets must be diversified in order to broaden Alberta's economic base and resilience to market fluctuations

New and transformative technologies are needed to ensure long-term, sustainable development of Alberta's resources for the benefit of all Albertans. These factors are the starting point for AI-EES' development of focused programs and activities in three strategic areas.

Consultation and Alignment

AI-EES is combining the activities of two well-established and credible entities (AERI and AWRI). As such, many of the consultations and alignment activities are building on past successes and relationships. AI-EES acknowledges that these consultations are on-going and engagement with other stakeholders is done both formally and informally. AI-EES' strategy has been developed by consulting with many different organizations.

The table below maps the direct AI-EES collaborative effort with the other Alberta Innovates corporations, Government of Alberta (GOA) departments, industry and Campus Alberta.

AI-EES PROGRAMS	ALBERTA INNOVATES CORPORATIONS	KEY GOA MINISTRIES	INDUSTRY	CAMPUS ALBERTA
Recovery & Processing	High	High	High	High
Clean Carbon	Low	Medium	High	High
Unconventional Gas	Low	Low	Medium	High
Water Program (AWRI)	Medium	High	Medium	High
Oil Sands Tailings	Medium	High	High	High
Enhanced Ecology	Low	Medium	High	Medium
Carbon Capture & Storage	High	High	High	High
Renewable Energy	Medium	Medium	Medium	Low
Alternate Fuels	Medium	High	Medium	Low

Figure 4: This chart illustrates the collaboration with the other Alberta Innovates corporations, key GOA departments, industry and Campus Alberta in support of AI-EES' programs and priorities. A high rating indicates active projects or initiatives with these partners. A medium rating denotes past activity or projects in the planning stage. A low rating indicates areas and partners where AI-EES is maintaining a 'watching brief'.

GOVERNMENT OF ALBERTA DEPARTMENTS

AI-EES has established working committees with government departments to discuss specific issues and opportunities involving energy and environment research and innovation and to develop projects that will benefit all parties. We have formalized the "Technology Informing Policy" (TIP) program, through a Memorandum of Understanding that four departments have signed. AI-EES has staff members that regularly meet with counterparts in other departments to delve into opportunities for co-sponsorship of projects. AI-EES has a strong track record of working with other departments on several initiatives, including Carbon Capture and Storage, Advanced Recovery Pilots, Bitumen Royalty In Kind, Life Cycle Analysis and *eco*Trust.

UNIVERSITIES, ALBERTA INNOVATES CORPORATIONS, AND OTHER GOVERNMENT ORGANIZATIONS

AI-EES has worked closely with universities and other government organizations for many years. Board members of AI-EES have been drawn from some of these organizations to ensure there is collaboration and to pursue synergies where possible.

The predecessor organizations of AI-EES and Alberta Innovates – Technology Futures have worked together on numerous projects over many years. These relationships will continue in projects involving carbonates, in-situ recovery, and tailings. Partnerships with Alberta Innovates – BioSolutions includes work in bio-energy, waste and biomass to produce bio-fuels and biological sinks. Work with Alberta Innovates – Health Solutions will lead to integration of work around healthy aquatic systems and impacts of climate change on humans.

INDUSTRIAL ASSOCIATIONS AND NON-GOVERNMENT ORGANIZATIONS (NGOS)

AI-EES is a member of a variety of associations and provides leadership by sitting on their boards. Staff members regularly interact with their peers in a variety of meetings, technology workshops, and conferences.

INDUSTRY

Most of AI-EES projects have funding from industry partners. AI-EES staff work closely with industry in developing ideas for research and innovation projects and in launching co-funding opportunities.

AI-EES Board members have significant industry and business experience and provide strategic leadership and oversight. Board members are often called upon by provincial, national and international organizations to provide advice and are in a position to influence industry and government directions in research and technology.

AI-EES Program

Based on the above analysis, AI-EES is focusing on three strategic areas: Energy Technologies, Environmental Management, and Renewable and Emerging Resources with three primary goals:

- **Deliver the lowest carbon emissions clean fuels and electricity;**
- **Have the best available environmental technologies and management systems to sustain the environment and economy; and**
- **Make Alberta into a renewable and emerging energy powerhouse.**

The program components are shown schematically below.

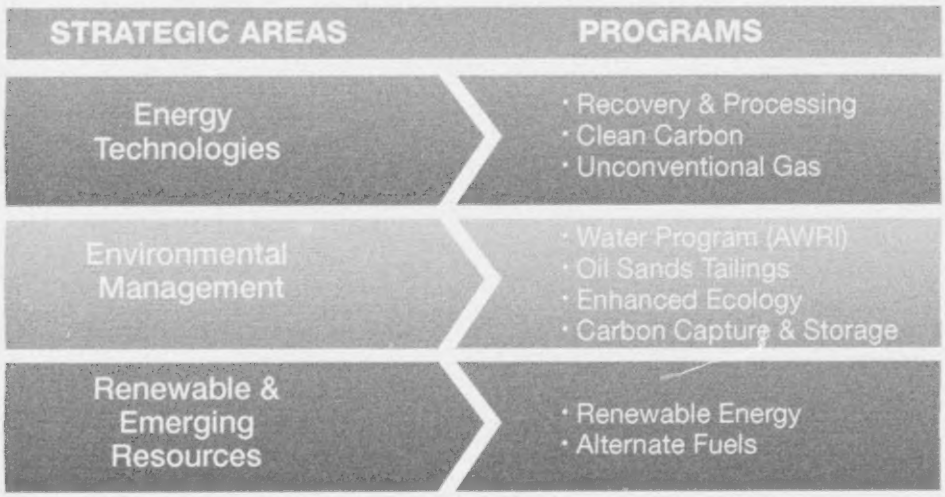

Figure 5: Illustrating AI-EES' Strategic Areas and Programs.

STRATEGIC ALIGNMENT

A fundamental component of the new research and innovation system is to build stronger synergy and connections among the Alberta Innovates corporations, government ministries, post-secondary institutions and other stakeholders, in order to better address government priorities. Enhancing alignment and coordination among industry groups is also very desirable. Therefore, AI-EES is developing its strategic business plan in consultation with relevant ministries, the other Alberta Innovates corporations, and with other research funders and performers. The table below maps the alignment of the AI-EES programs to the four goals of the Alberta Research and Innovation Plan – Economic Diversification and Competitiveness, Environmental Stewardship, Social Well-Being and Health, and Talent and Skills.

AI-EES PROGRAMS	ECONOMIC DIVERSIFICATION AND COMPETITIVENESS	ENVIRONMENTAL STEWARDSHIP	SOCIAL WELL-BEING AND HEALTH	TALENT AND SKILLS
Recovery & Processing	High	Medium	Low	High
Clean Carbon	High	Medium	Low	High
Unconventional Gas	High	Low	Low	Low
Water Program (AWRI)	Low	High	High	High
Oil Sands Tailings	Medium	High	Low	High
Enhanced Ecology	Medium	High	High	Medium
Carbon Capture & Storage	Medium	High	Medium	High
Renewable Energy	High	Medium	Medium	High
Alternate Fuels	High	Medium	Medium	High

Figure 6: This chart rates the AI-EES programs and the extent of their support for the Alberta Research and Innovation Plan. A high rating indicates that there are one or more active initiatives supporting the goals. A medium rating denotes active initiatives that are indirectly supporting the goals. A low rating is an indication that the initiatives in the program area are not linked to a specific goal.

RELEVANT GOA POLICIES AND STRATEGIES

AI-EES has studied the following relevant government strategies and identified areas where there are synergies and gaps. By working with the responsible government department, AI-EES will build opportunities for future work.

- *Alberta Research and Innovation Plan*, Alberta Advanced Education and Technology (September 2010)
- *Provincial Energy Strategy*, Alberta Energy (December 2008)
- *Responsible Actions: A Plan for Alberta's Oil Sands*, Alberta Treasury Board (February 2009)
- *Alberta's 2008 Climate Change Strategy*, Alberta Environment (January 2008)
- *Renewed Water for Life Strategy*, Alberta Environment (November 2008)
- *Tailings Management Framework*, Alberta Environment (in development)
- *Land-use Framework*, Alberta Sustainable Resource Development (December 2008)
- *Alberta Nanotechnology Strategy*, Alberta Advanced Education and Technology (April 2007)
- *Directive 074 – Tailings Performance Criteria and Requirements for Oil Sands Mining Scheme*, Energy Resources Conservation Board (February 2009)

KEY PRINCIPLES

The following form the key principles for AI-EES investments:

- Secure maximum value from all of Alberta's energy resources, while balancing economic, environmental and social interests
- Improve environmental performance
- Provide science-based information for effective water management
- Reduce the environmental impacts of hydrocarbon extraction and processing
- Increase deployment of clean energy – including renewables
- Increase energy efficiency
- Increase access to, and effectiveness of, energy markets
- Stimulate economic development and accelerate commercialization in Alberta
- Transfer technology to the appropriate sectors
- Inform policy

Applying these principles will allow us to advance critical technologies to commercial application that will give Alberta a sustainable competitive advantage in world markets.

THE AI-EES APPROACH

"We need technology more than ever today to keep our energy industry competitive and sustainable."[3]

AI-EES takes a strategic view, linking knowledge and needs through competitive technology intelligence and foresighting. This foresighting includes consultations with government departments and agencies, industry and other research and development organizations both locally and globally. The AI-EES strategy is based on a clear and realistic diagnosis of the challenges, and application of strong principles and processes. This approach to overcome the challenges identified will result in coordinated and focused actions.

AI-EES implements its plan by working with partners to create strategic programs that will fulfill its mandate, vision and mission. In creating the programs, AI-EES and partners will also identify gaps in knowledge and select the best partners to fill those gaps. Research providers from Campus Alberta, Alberta Innovates and from around the world will fill these roles.

RESEARCH, ANALYSIS AND TECHNOLOGY INFORMING POLICY

To build and enhance collaboration and leverage resources, AI-EES developed a Memorandum of Understanding with Alberta Energy, Alberta Environment, Finance & Enterprise and Sustainable Resource Development to create a formal mechanism called "Technology Informing Policy" (TIP) for facilitating, coordinating and promoting technology innovations, which are important from a policy development and strategic business planning perspective.

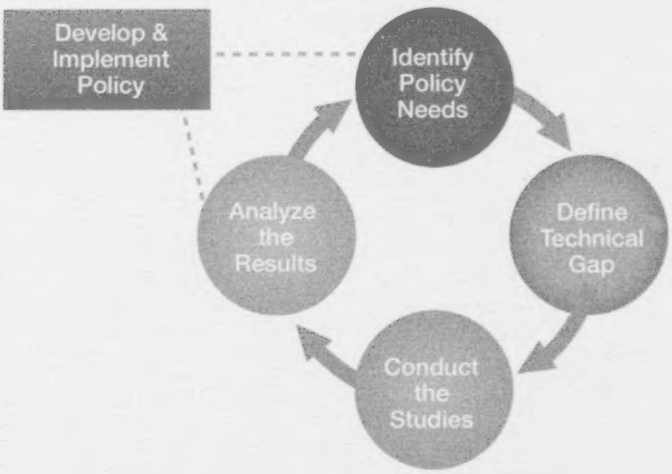

Figure 7: Illustrating the TIP Fund

This mechanism provides the framework for AI-EES to work with key GOA departments to ensure that policy decisions and strategies are informed by sound technical analysis. AI-EES and the departments are involved at all stages of the process. However, development and implementation of policy is done by the relevant ministries, as shown by the dotted lines.

3 Alberta's Provincial Energy Strategy 2008, "Launching Alberta's Energy Future", P. 16

Examples of projects involving research analysis and technology informing policy include:

- Tailings technology cost study
- Life cycle analysis study
- Alternate fuel study
- Steam Assisted Gravity Drainage (GHG) energy efficiency roadmap
- Centralized coke gasification study
- Chemical cluster study
- Energy, carbon environmental and water modelling

CLIMATE CHANGE AND EMISSIONS MANAGEMENT CORPORATION (CCEMC)

AI-EES is intimately involved with, and has staff assigned to participate in all of the CCEMC funded projects and programs. AI-EES provides strategic advice, technology adjudication and project management for the CCEMC as well as being the technology arm of GOA departments on strategic initiatives that require expertise in energy and environmental research and technology (see below). This places AI-EES in a strong position to connect the business needs of government and industry with the research expertise in universities and Alberta Innovates – Technology Futures to promote Alberta's strategic priorities in energy and environment.

The figure below illustrates the central role that AI-EES plays as the technology arm of both the CCEMC and Alberta departments in energy and environment and as a major force in promoting innovation, collaboration and an integrated approach to research and technology.

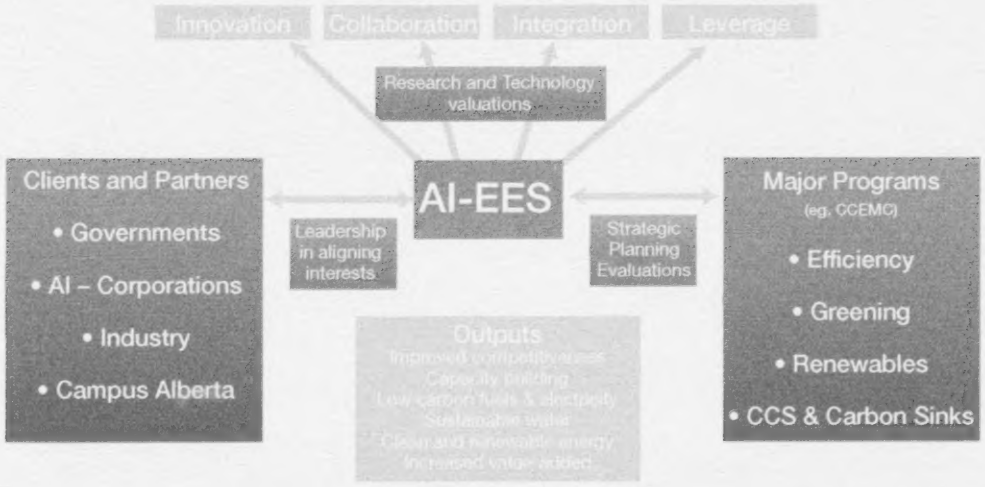

Figure 8: Illustrating the central role that AI-EES plays in delivering on Alberta's priorities in energy and environment research and technology.

STRATEGIC RESEARCH AREAS

"New ideas and new technology will be the keys to Alberta's continued economic vitality. Innovation will be front and centre in Alberta's drive to lead the next generation economy."[4]

AI-EES has three strategic areas with specific goals that support Alberta Government strategies and priorities. The goals are achieved through programs and projects that are carried out with public and private sector partners and focus on enabling technology platforms. These goals are shown in the tables below, which provide a high level summary of each of the strategic areas.

GOALS		
Goal 1. Deliver lowest carbon-emissions clean fuels and electricity to local and world markets	**Goal 2.** Develop critical environmental management systems for a sustainable economy	**Goal 3.** Transform Alberta into a renewable and alternate energy powerhouse – a major contributor to Alberta's new economy
PROGRAMS		
• Recovery and Processing • Clean Carbon • Unconventional Gas	• Water Program (AWRI) • Oil Sands Tailings Management • Enhanced Ecology • Carbon Capture & Storage	• Renewable Energy • Alternate Fuels
TECHNOLOGY PLATFORMS		
• Advanced recovery • Gasification • Separation technologies • Advanced materials and monitoring	• Life cycle analysis • Nanotechnology • Catalysis • Biotechnology	
STRATEGIC PARTNERS		
• CCEMC • Climate Change Central • U.S. Department of Energy • Alberta Innovates – Technology Futures • Alberta Innovates – BioSolutions • Natural Resources Canada • Carbon Management Canada • Alberta Helmholtz Initiative • University R&D	• Power industry • Oil sands industry • International companies and organizations • European Union R&D organizations • Alberta Departments of Energy; Environment, Finance & Enterprise and Sustainable Resource Development	

4 Speech from the Throne, April 15, 2008, page 3

PRIORITY PROGRAMS

The table below provides a high level description of the priority programs and the desired outcomes and impacts.

STRATEGIC AREA	PRIORITY PROGRAM	DESCRIPTION OF MAJOR GOALS
Energy Technologies	Recovery and Processing	Achieve a competitive and diversified hydrocarbon industry that maximizes recovery of conventional oil and oil sands and produces higher value products, including refined fuels and chemicals, while reducing water consumption, GHG emissions, the energy required for production, and the overall environmental footprint.
	Clean Carbon	Adapt and integrate technology and knowledge for the effective utilization of coal and other low-value carbon fuels to transform them into a clean energy source for the production of electricity, heat and chemicals with minimal environmental impact
	Unconventional Gas	Achieve the maximum possible recovery from the Province's vast unconventional gas resources, such as shale gas, with minimal impact on the environment
Environmental Management	Water Program (AWRI)	Support scientific research and innovation to promote policies and actions that achieve Alberta's Water for Life goals: to ensure safe and secure drinking water; healthy aquatic ecosystems; and water sources for a sustainable economy
	Oil Sands Tailings	Enable the industry to achieve the long-term objectives set out by the Energy Resources Conservation Board (ERCB) and Alberta Environment, to minimize and eventually eliminate long-term storage of fluid oil sands tailings
	Enhanced Ecology	Develop the technologies and performance matrix to achieve environmental sustainability in Alberta. This includes water, land, and air management, and sustained biodiversity; using life cycle analysis (LCA) and sustainability indices as performance measures and benchmarking tools
	Carbon Capture & Storage (CCS)	Develop cost effective carbon capture, safe and reliable geological storage, and CO_2 enhanced oil and gas recovery technologies to meet Alberta's GHG reduction goals; develop monitoring, measurement, and verification technologies to support policy and regulatory developments
Renewable and Emerging Resources	Renewable Energy	Demonstrate novel geothermal and bioenergy technologies which utilize municipal solid waste, forestry and agricultural residues, and produce power, hydrogen and liquid fuels
	Alternate Fuels	Support the development of underground coke gasification and low carbon and higher valued fuels

PERFORMANCE TRACKING

AI-EES uses the SMART Objectives Evaluation Matrix (based on the ProGrid® methodology) to measure progress and to ensure that government investments are spurring advancements toward long-term targets. Progress within each strategic and program area is measured annually identifying the Innovation Capacity and the Innovation Impact achieved by AI-EES over a period of time.

The high level evaluation matrix that AI-EES is using at the highest level evaluates 8 criteria.

INNOVATION CAPACITY	ENABLERS	INNOVATION IMPACT
Energy Strategies	Management Capacity	Energy Technologies
Environmental Strategies	Partnerships	Environment Management
	Funding	Renewable and Emerging Resources

In fall 2010, during the first full year of operations for AI-EES, the Board and Staff were interviewed to determine a current status for the new corporation. The figure below shows that overall AI-EES is on-track relative to the 2010 transition year with the basic elements of a well formulated strategy and management and oversight capacity in place. The funding gap is seen as the major barrier to marching the organization towards achieving the 2020 and 2030 goals.

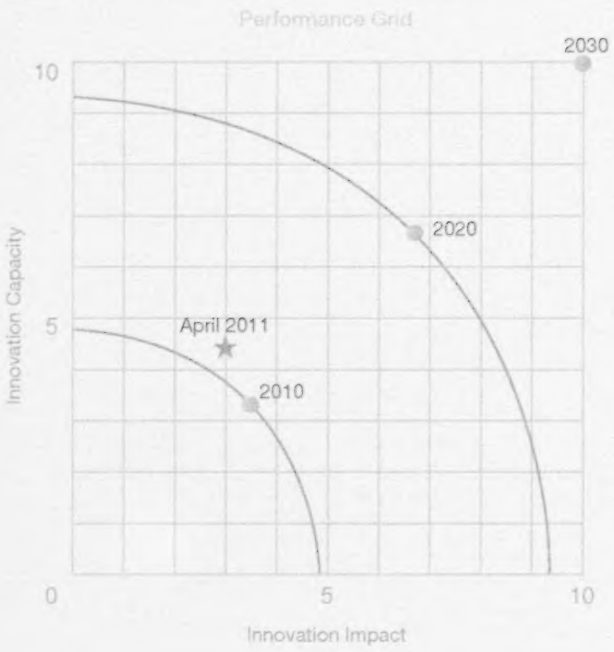

Figure 9: Illustrates the year 1 starting point for AI-EES based on its new strategies and organization model.

PROGRAM OUTCOMES

The performance outcomes by which progress over the five-year plan will be assessed are shown in the following table.

PROGRAMS	OUTCOMES
Recovery and Processing Clean Carbon Unconventional Gas	• Clean power generation from fossil fuels with CO_2 capture • Value-added approach (upgrading hydrogen, clean power and petrochemical feedstocks production) from oil sands byproducts • Reduced environmental footprint of bitumen recovery and processing adopted as industry standard • Game-changing technologies for recovery and processing • Alberta bitumen and heavy oil production increased
Water Program (AWRI) Oil Sands Tailings Enhanced Ecology Carbon Capture and Storage	• Alberta's 2020 and 2050 GHG emission reduction goals achieved • Technologies and information made available for government to make policy and regulations for carbon storage • Alberta has secure drinking water and healthy aquatic ecosystems, the water resources for a sustainable economy • Water use intensity in energy sector is reduced by 50% and the best practices adapted in agriculture • Evidence-based information to government, water managers and industry on development of new policies and regulations • Directive 074 goals achieved by oil sands industry • Technologies and information made available for government to make policy and regulations for oil sands tailings • The best technologies and practices made available for air, water, and land management and a healthy biodiversity in Alberta • Internationally recognized Life Cycle Analysis models and sustainability index developed as yardsticks for Alberta's resource development and environmental performance
Renewable Energy Alternate Fuels	• Commercial production of geothermal and biomass resources • Strong, world-class cluster of technologies such as underground coal gasification, for emerging resources

Capacity Requirements

CAPACITY GAPS

The table below provides a listing of the research and development programs in energy and environment that focus on capacity building – building the people and infrastructure that will be required for Alberta's competitiveness in the global economy. These programs are currently supported by AI-EES, AWRI and Alberta departments.

PROGRAM/NETWORK	AI-EES STRATEGIC AREA/PROGRAMS	ESTIMATED ANNUAL ALBERTA FUNDING REQUIRED
AERI/ARC Core Industry (AACI) Program	*Energy Technologies* – Recovery and Processing	$1.1 million
National Centre for Upgrading Technologies (NCUT)	*Energy Technologies* – Recovery and Processing	$0.65 million
Centre for Oil Sands Innovation (COSI)	*Energy Technologies* – Recovery and Processing *Environmental Management* – Water Program (AWRI)	$5.0 million
Alberta Ingenuity Centre for In Situ Energy (AICISE)	*Energy Technologies* – Recovery and Processing	$0.5 million
Alberta Ingenuity Centre for Carbon and Mineral Processing	*Environmental Management* – Carbon Capture and Storage	$1.4 million
Nine Existing University Chairs	*Energy Technologies* – Recovery and Processing, Unconventional Gas *Environmental Management* – Water Program (AWRI) *Renewable and Emerging Resources* – Alternate Fuels	$1.1 million
University Research (project specific not included in the above programs)	*Environmental Management* – Water Program (AWRI)	$3.2 million
Carbon Management Canada	*Environmental Management* – Carbon Capture and Storage	$5 million
Helmholtz Alberta Initiative	*Environmental Management* – Carbon Capture and Storage, Water Program (AWRI)	$5 million
Alberta Biodiversity Monitoring Institute (ABMI)	*Environmental Management* – Enhanced Ecology	$4 million

A number of these programs are coming up for renewal and there is a risk that some will not be supported due to lack of funding. AI-EES' approach is to rigorously evaluate the above programs to ensure that they are delivering high quality results that are relevant to Alberta's strategic needs and that they form an integral part of the innovation system.

With the new mandate for AI-EES a number of new capacity gaps were identified – high quality water monitoring, tailings technology and management, biodiversity solutions, biological systems, and energy efficiency. Developing research capacity in these areas will require prioritizing and re-balancing the portfolio based on available funding. Additional funding will be required to create these as new long term programs.

In terms of capacity building at Alberta's post-secondary institutions, AI-EES' strategy is to focus on supporting Research Chairs due to the considerable performance requirement demanded of the Chair holder and the high leverage factor.

TECHNOLOGY TRANSFER CAPACITY GAPS

Alberta is lacking in capacity for large scale demonstration projects and training of technology specialists who can advance technology innovations in energy and environment while engaging the research support at Alberta Innovates and Campus Alberta organizations. This is a shared responsibility between AI-EES and industry to move investments in technology research and development into commercial products, processes and systems. The capacity to transfer technology from field applications and demonstration to deployment by industry is critical for Alberta's long-term economic prosperity.

AI-EES, like its predecessor AOSTRA, believes that it is imperative to imbed staff into major projects to increase the potential for success and ensure that Alberta's priorities are advanced. AI-EES is currently unable to do this due to lack of resources with the requisite domain expertise. These experts would identify promising technologies, analyze the results from funded projects to determine a new line of investigation, and work with industry to advance commercial opportunities.

BUDGETARY GAPS

Reaching the targets outlined in this strategic business plan requires sustained, planned and increased investment in energy and environmental innovation, and the integration of research efforts across government, industry, research providers and universities. AI-EES provides the strategic leadership and initial investment that catalyzes additional investment from industry. Long-term funding from industry is needed to propel the investments to commercial developments.

To fulfill its expanded mandate and long term vision, AI-EES will build on its legacy to implement current planned projects and to initiate new projects as additional funds are confirmed.

The illustration below provides a summary of funding envelopes that AI-EES and its government partners have used for investing in projects. These funds are invested in stage-gated projects carried out in partnership with selected companies, government departments and agencies, and universities to meet the government goals. This model coordinates and deploys the skills and expertise of key partners to achieve the desired outcomes. By so doing, AI-EES builds Alberta's capacity across the full research and technology development and implementation path.

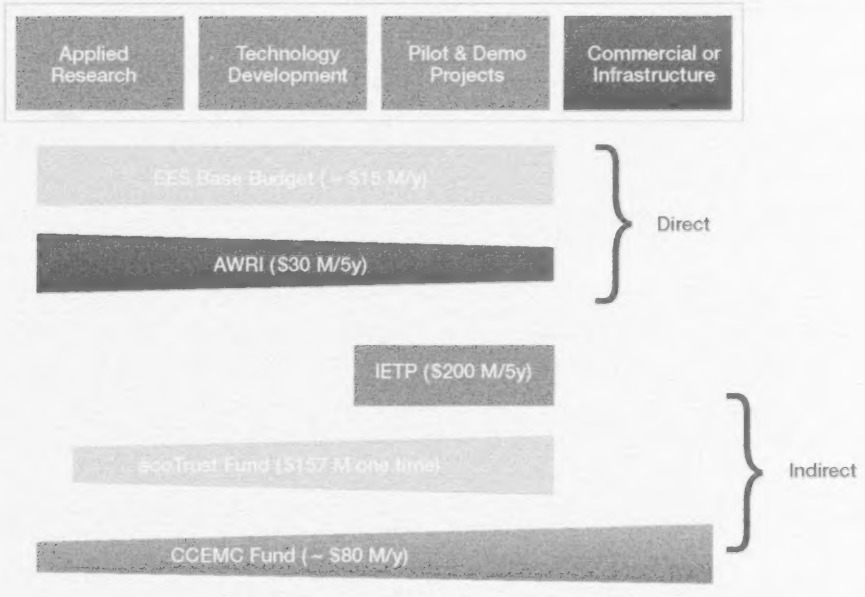

Figure 10: Illustrates the linkages between AI-EES and current government programs, as well as their associated funding envelopes.

AI-EES' impact is constrained by its current budget that was created at a time of government funding challenges. Some funding programs are ending. AWRI's initial funding of $30 million has been fully allocated and will be spent by 2013-14. The Energy Innovation Fund was completed in 2008-09. This program funded significant pilot projects in the Hydrocarbon Upgrading Demonstration Program, clean coal, underground coal gasification and waste-to-fuels. The Innovative Energy Technology Program will be ending after the current competition. These funds supported pilots in conventional oil and gas projects in the field. The *eco*Trust program was one time funding to support major environmental field projects. The CCEMC funding is limited in its scope and is restricted by being a compliance mechanism. Securing additional funds will allow AI-EES to fund new opportunities and makes it possible to consider funding further demonstration and pilot projects that could have major impacts for Albertans.

FUNDING PRIORITIES

Research and innovation require long term patient funding. In the early years, the investments are relatively small. As technology matures, greater investments are made at each stage. Pilots and demonstrations typically require hundreds of millions of dollars of investment prior to commercialization.

AI-EES has identified three major projects that will require significant funds over the next 5 to 10 years with the bulk of funding required in later years of the investment cycle. The immediate recommended priorities for funding include:

- **Advance Commercial Deployment of Tailings Technology** - Oil sands tailings management is a major technology challenge for the mined oil sands industry and a system approach is required to develop and accelerate end-to-end solutions for both tailings and water. The commitment of funds will be subject to similar investment and participation by the oil sands mining industry and agreement to share the results of technology deployment at a commercial scale. Estimated cost is $250 million over 10 years.
- **Renew funding for Water Program (AWRI)** - In order to maintain the momentum of Alberta being a world leader in water management and to capitalize on the investments to-date, it is important that Alberta renew its funding commitment to the AI-EES Water Program (AWRI). This will expand the province's knowledge and research expertise in water and help achieve the goals of the Water for Life Strategy for safe, secure drinking water, healthy aquatic ecosystems and reliable and sustainable quality water supplies for a prosperous economy. Estimated cost is an average of $5 million per year.
- **Invest in Capacity Building** - Capacity building will be structured around university chair holders due to their high accountability to funders and the high degree of relevancy to industry. AI-EES has identified potential chair holders in several areas where capacity building is required such as sustainable engineering applications, environmental monitoring, biodiversity solutions, biological systems, and energy efficiency. None of these areas can be funded within the current budget. There is, however, a high probability of leverage with industry, NSERC and other potential funders.

AI-EES looks forward to an improved ability to fund programs and share risks of moving strategic technologies through piloting and large-scale demonstration towards implementation. The current funds are sufficient to maintain operations but need to be expanded to take advantage of the opportunities to invest in potentially game-changing breakthrough projects.

With additional funds, AI-EES could fund the following types of strategic initiatives:

Energy Technologies

- Expanding advanced clean coal and hydrocarbon upgrading programs to help secure long term, affordable sources of energy for Albertans and for export
- Focusing on value-added chemicals by creating a Petrochemical Products Program to add revenue streams to the province
- Maintaining and enhancing major research and pilot programs for conventional oil recovery and unconventional gas, which again will provide energy and revenues to the province

Environmental Management

- Developing and demonstrating transformative CO_2 capture technologies to reduce CO_2 capture cost and enable commercial-scale Carbon Capture and Storage projects

Renewable & Emerging Resources

- Converting biomass, waste, and low valued hydrocarbons into bio-energy to develop cleaner sources of energy for Albertans
- Developing an alternate fuels program to support new sources of energy
- Demonstrating wind, solar and geothermal that would reduce greenhouse gas emissions
- Applying nanotechnology in energy and environmental related areas (notably in materials, catalysis and separation technologies) as identified by the nanotechnology innovation strategy to put Alberta at the forefront of these inventions
- Developing underground coal gasification as a clean energy source by converting deeply buried coals to hydrogen generation, electricity and heat, with CO_2 capture for enhanced oil recovery

BUDGET

	2010-11 Forecast	2011-12 Budget	2012-13 Budget	2013-14 Budget	2014-15 Budget	2015-16 Budget	Notes
Revenues							
Grants from Government of Alberta							
Base Operating Grant	15,925	15,925	15,925	15,925	15,925	15,925	1
Ingenuity Centres	3,400	2,600	1,650				
Water Research	10,648	6,944	1,863	895	90		2
New Funding Required				2,786	20,279	19,809	
Interest Income	400	200	100	100	100	100	3
Other Income							
Reimbursement of Expenses	890	1,000	1,000	1,000	1,000	1,000	4
IP Revenues and miscellaneous		700	700	700	700	700	5
	31,263	27,369	21,238	21,406	38,094	37,534	
Expenses							
Energy Technologies	8,413	9,453	6,109	1,884	1,885	1,525	
Environmental Management	3,605	2,023	500	1,000	1,000	1,000	
Water Research	9,597	6,156	1,276	620	90		6
Renewable and Emerging Resources	914	5,710	430	380	380	280	
Program Administration							
Energy and Environment	2,495	2,901	3,003	3,159	3,008	2,998	7
Water	809	556	355	275			8
Technical Support Services							
Energy and Environment	1,457	1,338	986	701	731	731	9
Water	242	232	232				
	27,532	28,369	12,891	8,019	7,094	6,534	
NET OPERATING RESULT	3,731	(1,000)	8,347	13,387	31,000	31,000	
ACCUMULATED CARRYOVER							
Beginning of Year	7,735	11,466	9,466	8,813	3,200	3,200	
Less Strategic Unfunded Initiatives							
Tailings		1,000	1,000	5,000	15,000	15,000	
Water			3,000	4,000	6,000	6,000	
Capacity Building			5,000	10,000	10,000	10,000	
Net Operating Result	3,371	(1,000)	8,347	13,387	31,000	31,000	
End of Year	11,466	9,466	8,813	3,200	3,200	3,200	10

Over the long term, AI-EES will not have a budgetary surplus assuming that the strategic programs in Tailings, Water and Capacity Building go ahead as planned. In the first couple of years, these initiatives are in the planning stages and small expenditures are required. As the projects mature toward a pilot and commercialization stage, very large expenditures will be required.

Notes:

1. Per Budget 2011
2. Allocation of $20.8 million available at March 31, 2010 - assumes no new funding for AWRI
3. Interest is estimated at a 1% interest rate
4. Reimbursement of expenses includes revenues from providing services to the CCEMC
5. No Intellectual Property revenues expected - some "project participation" revenues
6. Spend down of initial $30 million grant. A request for renewed funding for water is underway
7. Assumes 4 new hires from 2011 to 2014 - subject to further approval
8. Reduction in AWRI Board expenses
9. CCEMC expenses for reviewers, other peer reviews, purchase of specialized studies, scientific consultants
10. AI-EES will retain minimum carryover of $3.2 million as a contingency fund for reduction in budget and potential wind up costs